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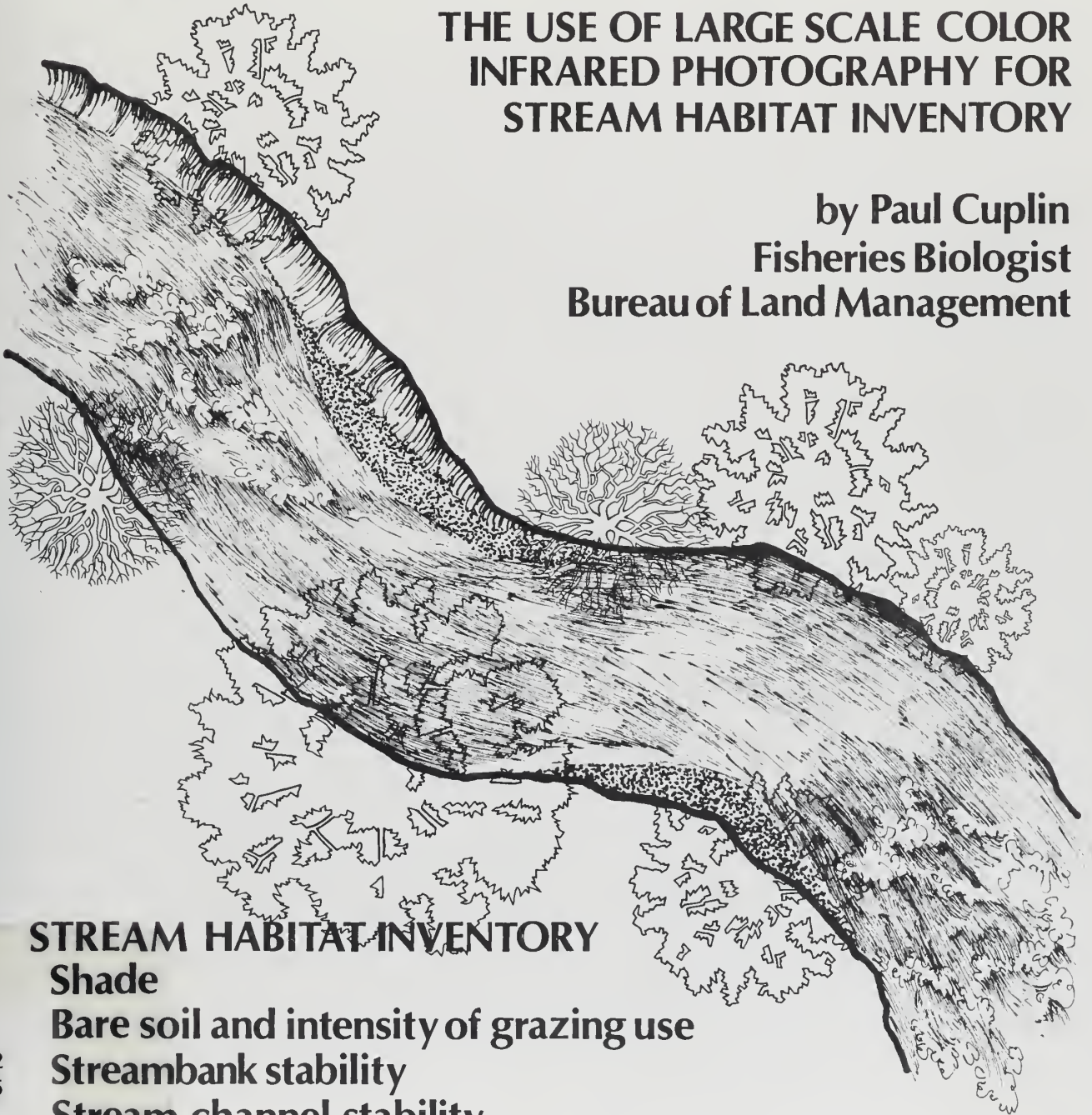


## TECHNICAL NOTE

U.S. DEPARTMENT OF THE INTERIOR – BUREAU OF LAND MANAGEMENT

# THE USE OF LARGE SCALE COLOR INFRARED PHOTOGRAPHY FOR STREAM HABITAT INVENTORY

by Paul Cuplin  
Fisheries Biologist  
Bureau of Land Management



### STREAM HABITAT INVENTORY

#### Shade

Bare soil and intensity of grazing use

Streambank stability

Stream channel stability

Sedimentation of streambed

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THE USE OF LARGE SCALE COLOR INFRARED PHOTOGRAPHY  
FOR STREAM HABITAT INVENTORY

BY

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## Abstract

A method of stream habitat inventory using photo interpretation of large scale color infrared photography is described. The supporting methods of ground truth, targeting for aerial photographic identification and photo scale, film format exposure for water penetration of clear water, lens filters, and description of acceptable weather and sunlight conditions for optimum film exposure are identified.

## Introduction

Stream inventories must often be completed in a restricted time period with a limited staff to meet environmental statement deadlines or bureau planning priorities. To accelerate stream habitat inventory a method of large scale color infrared photography (CIR) with water penetration and interpretation of five components of stream habitat are used to categorize existing stream habitat. The present aerial photography available in bureau field offices is not large enough scale to allow for interpretation of stream habitat conditions.

Ground truth sampling of a stream prior to aerial photography is required for verification of photo interpretation. Photographic scale and location are verified by targets placed at ground truth sites.

The aerial photography will provide a resource data base that can be used to determine existing conditions and to monitor stream habitat responses to land management.

## Field Inventory Prior to Aerial Photography

Each stream that has been selected for photographic coverage will be sampled in the field and a pair of identifying targets placed on the stream bank.

The ground truth stream sampling unit will be (one tenth mile) 528 feet. The stream habitat inventory profile (see Illustration 1) will be used for ground truth and photo interpretation.

## Targets

Place two targets of white fools cap paper 2 feet by ten feet in a pattern that can be identified in the aerial photograph.

The targets not only aid in identifying the stream but will serve to aid in scale determination. Locate the ground truth site on a topographic map for photo interpretation.

## Acquisition of Large Scale Color Infrared Stream Photography

It is recommended that a reliable aerial mapping firm provide the photographs that are required. The specifications for achieving the high quality photography that will allow you to analyze stream habitat conditions are very specific and outlined in detail in the text. An example specification detail sheet is presented in Illustration III. Obtain current specifications for color infrared photography contracting from Denver Service Center Office of Special Mapping prior to contracting for stream photography.

### Photographic Format

Photograph size or format must be large enough to identify location of the photograph by comparison with U.S.G.S. 7 ½ min. topographic map. 5" x 5" is the smallest acceptable format for a resource data base and for rapid photo interpretation. This format is often only available from the defense department. Aerial mapping companies may only have 9" x 9" format available.

The smaller format of 35 mm and 70 mm have utility if you are doing your own aerial photography however, location identification, handling of film and ease of photo interpretation is much more time consuming as compared to the 5" x 5" or larger photographs.

### Film

Color infrared Kodak film 2443 is recommended. The definition of detail on the ground is enhanced in CIR as compared to black and white or color photography.

The film manufacturers instructions state that unprocessed Kodak aerochrome Infrared Film 2443 and finished transparencies should be stored in a cool, dry place. Unexposed film should be kept in a refrigerator (at 55°F or lower) in its original sealed package. If film must be stored for long periods, the sealed film should be stored at 0 to -10°F. Exposed film should be processed as soon as possible after exposure to avoid changes in the latent image.

### Exposure for Water Penetration

Color infrared film correctly exposed, produces a dark magenta image from clear streams. Water penetration is achieved by overexposing color infrared film ½ f stop. The three layered color infrared film reacts to overexposure by allowing penetration of the green layer resulting in recording of streambottom characteristics below the stream water surface. A Wratten 12 filter is used with color infrared film.

Water penetration can not be achieved during stream flooding with muddy or turbid water, nor can streams with year round turbidity or glacial flour be penetrated.

Ektachrome X film can be used to penetrate the water of large streams where only algae caused turbidity is present. This technique does not allow for good definition of riparian vegetation. A Wratten 3 filter with 2 f stop overexposure is used for water penetration with Ektachrome X film (Lockwood and Perry).

### Photographic Scale

A scale of 1:1000 is required for photo interpretation of the five habitat components identified in stream habitat inventory profile, i.e. stream cover, stream bank condition, stream bank stability, stream channel stability and sedimentation of streambed - the latter component can only be determined by a much greater magnification of the photo transparency than the other four components.

Smaller photographic scale will allow for the identification of some of the components of stream habitat.

### Photograph Endlap

Photograph overlap of 58% is needed for stereo interpretation of the components of the stream and adjacent area.

### Time of Day

Aerial photographs should be taken from 11 am to 1 pm for maximum sun azimuth in the contiguous 48 states. This will minimize shadow of tall trees and steep terrain.

### Time of Year

Photographs should be taken from June 1 to August 31 for maximum infrared or peak of green from vegetation in the lower 48 contiguous states. Exceptions would be the Southwestern United States where peak of green will occur in March or April, in Alaska peak of green will be later July through September.

### Cloud Cover

Photographs should not be taken if cloud cover is greater than 15 percent of any type of clouds.

## Photo Interpretation

Locate and interpret first the ground truth site in the aerial photographs. Once this has been completed compare photo interpretation with the ground truth rating, using stream habitat inventory profile Illustration I. Use the verification form Illustration II to compare ground truth and photo interpretation. If ground truth and photo interpretation agree continue on with the photo interpretation.

If they are not within a 5 percent agreement, go back to the ground truth site with aerial photos and recheck the ground truth.

Continue to interpret aerial photographs until a change in stream habitat conditions is apparent. Log on stream habitat inventory profile Illustration I the last frame number then begin a new form and continue again until a change in habitat classification is noted.

## Equipment for Photo Interpretation

A light table with 20 X stereoscope is used for rapid analysis of photographs. The transparencies are examined on the three hundred foot roll of film.

## Film Storage

Film is identified and stored in rolls approximately 300 feet in length.

## Summary

The speed of stream habitat analysis is approximately ten miles per hour. Correlation between ground truth and photo interpretation is extremely high and reproducible results can be obtained from any trained technician.



## Acknowledgements

Thanks are extended to Richard Kerr, Wildlife Staff Leader, Denver Service Center, Bureau of Land Management, who encouraged the development of remote sensing techniques for streams and to Fred Batson, Wally Crisco, Lanny Wilson, Carl Armour, Mark Hilliard and Art Oakley who each contributed to the development of this stream habitat inventory system.

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STREAM HABITAT INVENTORY PROFILE  
(This form to be used for field inventory or photo interpretation)

Stream \_\_\_\_\_ Date \_\_\_\_\_ Surveyor(s) \_\_\_\_\_ State \_\_\_\_\_ Dist. \_\_\_\_\_

Planning Unit \_\_\_\_\_ Site No. \_\_\_\_\_ Length of Stream Surveyed \_\_\_\_\_

Field Survey \_\_\_\_\_ Aerial Photograph \_\_\_\_\_ (Check one)

	80%+	4	60 - 80%	3	40 - 60%	2	40% or less	1
Stream Cover (% Shade)								
Stream Bank Condition (% Bare Soil)	5% or less	4	6 - 15%	3	16 - 25%	2	25% or more	1
Stream Bank Stability (% Bank Damage)	0 - 10%	4	20% or less	3	40% or less	2	41% or more	1
Stream Channel Stability (% Channel Movement)	5% or less	4	6 - 10%	3	11 - 15%	2	16% or more	1
Sedimentation of Streambed (% Silt)			10% or less	3	11 - 25%	2	26% or more	1

Column Totals [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

Stream Condition Rating for Length of Stream  
Evaluated - (Enter total score in appropriate space)  
Excellent 17 \_\_\_\_\_ Good 14-16 \_\_\_\_\_  
Fair 10-13 \_\_\_\_\_ Poor 5-9 \_\_\_\_\_

SUMMARY (Last page of inventory for each stream)

Field Inventory Total Number Stream Sites \_\_\_\_\_  
Stream Condition Rating No. Miles: Excellent \_\_\_\_\_ Good \_\_\_\_\_ Fair \_\_\_\_\_ Poor \_\_\_\_\_

Photo Interpretation Total Number Stream Miles Inventoried \_\_\_\_\_  
Stream Condition Rating No. Miles: Excellent \_\_\_\_\_ Good \_\_\_\_\_ Fair \_\_\_\_\_ Poor \_\_\_\_\_

ILLUSTRATION 1 (Continued)

<b>A. <u>High Stream Cover</u></b> (June - September; 11:00 am - 5:00 pm, MDT)	<u>Rating</u>
80% +	4. ___ Excellent
60 - 80%	3. ___ Good
40 - 60%	2. ___ Fair
Less than 40%	1. ___ Poor
<b>B. <u>Stream Bank Condition</u></b>	<u>Rating</u>
No negligible use/damage; vegetation <u>1/</u> well-rooted; sod intact; very little, if any erosion from vegetation areas, less than 5% bare soil showing.	4. ___ Excellent
Some use/damage; vegetation generally well-rooted; sod mostly intact; soil showing in places (6% to 15% bare soil showing overall); some surface erosion evident.	3. ___ Good
Use or damage close to sod; vegetation shallow-rooted; moderated surface erosion (16% to 25% bare soil showing overall).	2. ___ Fair
Heavy to severe use/damage; vegetation generally cropped to sod; considerable soil showing (over 25%) with sod damage serious; active surface erosion a serious problem.	1. ___ Poor
<u>1/</u> Primarily grasses, sedges and forbs.	
<b>C. <u>Stream Bank Stability</u></b>	<u>Rating</u>
<u>Bank Stable and Undamaged</u> - Partial or no evidence of bank damage; 90-100 percent of bank area free from use/damage. Little or no unnatural bank erosion or sloughing present.	4. ___ Excellent
<u>Bank Damage 20 Percent or Less</u> - Banks 80 to 90 percent free from use/damage. Some erosion and sloughing but fully recoverable after a season of rest.	3. ___ Good
<u>Bank Damage 40 Percent or Less</u> - Banks having received 20 to 40 percent damage from use/damage. Moderate to heavy bank erosion and sloughing during season(s) of use, and which continues during no use period(s). Conditions will not allow natural stability recovery of banks to a level greater than 60 percent stability.	2. ___ Fair
<u>Bank Damage Excessive</u> - Banks exhibiting greater than 40 percent damage. Severe bank damage and accelerated erosion and sloughing is present over virtually the entire bank surveyed. No evidence of bank recovery visible, and erosion is consistent.	1. ___ Poor
<b>D. <u>Stream Channel Stability</u></b>	<u>Rating</u>
No negligible lateral channel movement and bank erosion (cutting) (5%), scour, or changing channels.	4. ___ Excellent
Some lateral channel movement and bank erosion (5 to 10%), minor channel scour or changing channels within stream bed.	3. ___ Good
Frequent lateral channel movement (10 to 15%); moderate channel scour or channel change within stream bed.	2. ___ Fair
More than 20% lateral channel movement and bank cutting, changing channels and severe scour evident, and source of extreme sedimentation.	1. ___ Poor
<b>E. <u>Sedimentation of Stream Bed</u></b> - Percent of fine sediments (particles sand size and smaller) covering stream bottom (vetted parameter) materials.	<u>Rating</u>
Less than 10%	3. ___
10 - 25%	2. ___
More than 25%	1. ___

Illustration II

STREAM HABITAT INVENTORY PROFILE  
GROUND TRUTH (G.T.)/PHOTO INTERPRETATION (P.I.)  
VERIFICATION

State \_\_\_\_\_ District \_\_\_\_\_ Planning Unit \_\_\_\_\_

Stream Name \_\_\_\_\_ No. Feet G.T. \_\_\_\_\_

Location of G.T. \_\_\_\_\_

G.T. Target Pattern \_\_\_\_\_

Photograph Frame Number(s) P.I. \_\_\_\_\_

Comments \_\_\_\_\_

	Shade	Stream Bank Condition	Stream Bank Stability	Stream Channel Stability	Sedimentation of Streambed	Total Score
G.T.	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	3 2 1	_____
P.I.	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	3 2 1	_____
Difference between scores in percent of potential						_____

Example - Scores of 12 (63%) and 11 (58%) difference 5%.

Score	% of Potential		Score	% of Potential	
19	100	Excellent	13	68	Fair
18	85		12	63	
17	89		11	58	
		10	53		
16	84	Good	9	47	Poor
15	79		8	42	
14	74		7	37	
		6	32		
		5	26		

Illustration III

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
BUREAU OF LAND MANAGEMENT

Solicitation Number

SPECIFICATION DETAIL SHEET

Project Name and/or Number

LOCATION

State	District	Symbol	Square Miles	Linear Miles

DATES PHOTOGRAPHY MAY BE TAKEN

AERIAL CAMERA

Starting	Completion	Focal Length	Lens Type

Time of day photographs may be exposed:

FLIGHT ALTITUDE

TYPE

Above mean sea level	Above mean terrain	Scale of photography	Flight direction	Film to be used	Photographic prints	Number of each print

INDEX

<input type="checkbox"/> Photo Index	<input type="checkbox"/> Spot Index	Type of material	Number Required
Index Scale:			

PHOTOGRAPHY SPACING REQUIREMENTS

<input type="checkbox"/> B/H W/H decimal ratio	CHECK METHOD USED			<input type="checkbox"/> Percentage overlap
	Min.	Av.	Max.	
Base height ratio along lines of flight (endlap)				Endlap (overlap in line of flight)
Width height ratio between flight lines (sidelap)				Sidelap (overlap between adjacent flight lines)

Special requirements:





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The use of large scale color  
infrared photography for strea

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